



NASA SBIR 2012 Phase I Solicitation

A2.01 Unmanned Aircraft Systems Integration into the National Airspace System Research

Lead Center: AFRC

Participating Center(s): ARC, GRC, LaRC

The following subtopic is in support of the Unmanned Aircraft Systems (UAS) Integration in the National Airspace System (NAS) Project under the Integrated Systems Research Program (ISRP). There is an increasing need to fly UAS in the NAS to perform missions of vital importance to National Security and Defense, Emergency Management, Science, and to enable commercial applications. The UAS Integration in the NAS Project is structured under the following technical challenges:

- Airspace Integration - validate technologies and procedures for UAS to remain an appropriate distance from other aircraft, and to safely and routinely interoperate with NAS and NextGen Air Traffic Services (ATS).
- Standards/Regulations - validate minimum system and operational performance standards and certification requirements and procedures for UAS to safely operate in the NAS.
- Relevant Test Environment - develop an adaptable, scalable, and schedulable relevant test environment for validating concepts and technologies for UAS to safely operate in the NAS. The Federal Aviation Administration (FAA) regulations are built upon the condition of a pilot being in an aircraft.

There exist few, if any, regulations specifically addressing UAS today. The primary user of UAS to date has been the military. The technologies and procedures to enable seamless operation and integration of UAS in the NAS need to be developed, validated, and employed by the FAA through rule making and policy development.

The Project goal is to capitalize on NASA's unique capabilities and competencies by utilizing integrated system level tests in a relevant environment to eliminate or reduce critical technical barriers of integrating UAS into the NAS. The project is further broken down into five subprojects: Separation Assurance/Sense and Avoid Interoperability (SSI); Communications; Human Systems Integration; Certification; and Integrated Test and Evaluation. The fifth sub-project, Integrated Test and Evaluation, is responsible for developing a live, virtual, and constructive test environment for the other four subprojects. The first phase of the project includes the following:

- Conduct initial modeling, simulation, and flight testing.

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- Complete early subproject-focused deliverables (spectrum requirements, comparative analysis of certification methodologies, etc.).
 - Validate the key technical elements identified by this project.

The second phase includes the following:

- Conduct systems-level, integrated testing of concepts and/or capabilities that address barriers to routine access to the NAS.
- Provide methodologies for development of airworthiness requirements and data to support development of certification standards and regulatory guidance.
- Develop a body of evidence (including validated data, algorithms, analysis, and recommendations) to support key decision makers in establishing policy, procedures, standards and regulations, enabling routine UAS access in the NAS.

This solicitation seeks proposals, but is not limited, to develop:

- *Certified control and non-payload communications (CNPC) system* - Current civil UAS operations are significantly constrained by the lack of a standardized, certified control and non-payload communications (CNPC) system. The UAS CNPC system is to provide communications functions between the Unmanned Aircraft (UA) and the UA ground control station for such applications as: telecommands; non-payload telemetry; navigation aid data; air traffic control (ATC) voice relay; air traffic services (ATS) data relay; sense and avoid data relay; airborne weather radar data; and non-payload situational awareness video. New and innovative approaches to providing terrestrial and space-based high-bandwidth CNPC systems that are inexpensive, small, low latency, reliable, and secure offer opportunities for quantum jumps in UAS utility and capabilities. Of particular interest are:
 - Technologies for High power C-band amplifiers and highly linear C-band power amplifiers/linearization of high power C-band amplifiers.
 - Miniaturization of C-band radio components/systems.
- *A "Synthetic Vision System" for a ground control station (GCS)* - Integration of display technology that presents the visual environment external to the unmanned aircraft using computer-generated imagery in a manner analogous to how it would appear to the pilot in a manned aircraft. A "synthetic vision system" displays critical features of the environment external to the aircraft through a computer-generated image of the external scene topography using terrain and obstacle databases. Several research and technological developments have made synthetic vision systems possible. Fundamentally, these systems require only precise ownship location, a database, available graphics and computing capability and display media. In terms of safety benefits, synthetic vision may help to reduce many accident precursors including: Loss of awareness of vertical/ lateral path, terrain traffic, etc. Operational benefits may include transition from instruments to visual flight, non-normal and emergency situations, virtual visual self-spacing and station keeping capability, etc. SVS have been extensively studied and there is a vast body of knowledge on their application to manned aviation. Special interest is in the integration of a SVS into a UA ground control station to support operator in the loop, sense and avoid (SAA) functions for UAS operations in the NAS. Guidelines for sense and avoid requirements and functions are currently being developed by standards organizations (e.g., RTCA SC-203) and the FAA.
- *Weather information systems for GCS* - On-board, real-time graphic aviation weather information products have been developed and successfully implemented for manned cockpits. Their use is now widespread and their safety impact widely recognized. The applicability of such products for operators and ground control

pilots to enhance situation awareness and improve mission planning and execution is of interest to NASA. Systems such as the NASA developed Aviation Weather Information (AWIN) system that included software, data and data-link applications, color weather graphics such as composite-radar mosaic, lightning-strike data, wind data, satellite images and forecasts could be integrated into a ground control station to provide pilots with weather awareness before and during mission execution. Improved weather awareness should allow aircrews to avoid most weather-related problems through both pre-flight and en-route planning. While the use of these systems has been explored for military UAS operations, their applicability to civil and public operations has not yet been explored.

- *Operator Displays for Sense and Avoid Systems* - While guidelines for the integration of UAS operations in the NAS are being developed new SAA systems are being designed to provide the ground control pilot with situation awareness and the ability to execute required ATC procedures. SAA systems provide UAS with the capability to avoid collisions and remain well clear of other aircraft by means of sensor systems and equipment specifically designed for this purpose. SAA systems consist of surveillance sensors, data communications, threat detection and/or resolution logic and the display of traffic information and/or resolution guidance/advice. Of interest is the development of display technologies to enable ground control pilots to participate in any phase of the SAA process as indicated by operator procedures. These new technologies should utilize the vast experience and body of knowledge developed over the years for airborne/ground separation assurance systems, TCAS displays, and cockpit displays of traffic information. In addition, these new displays will exhibit unique and very challenging new problems associated with the nature of unmanned systems as well as the communication latencies and potential safety risks of failure conditions. Human factors considerations should be applied in the design of these systems.
- *Lost Communication Link Procedures and Operations* - The procedures followed by unmanned aircraft and their pilots when the command and control link is lost with the ground station are not standardized and frequently do not take into account ATC regulations. Each UAS appears to have custom-designed procedures for "lost link" despite the existence of well-established rules for pilots to follow when communication capability is lost. Research should establish a desired set of procedures to be followed that parallel the existing requirements, but departing from those where necessary to meet critical safety considerations. These procedures may be codified in technologies used by the unmanned aircraft or the pilot in the ground control station to maximize the predictability of the UAS' actions from an ATC perspective.
- *Safety Analysis and Methodologies* - UAS operations are untried in the civil NAS. Unlike other aircraft, there is not an extensive record of civil operations upon which to forecast the safety of UAS operations in the NAS. The introduction of UAS into the NAS raises many safety issues and concerns. Typically, anytime a new capability is added into the NAS, an Operational Safety Assessment (OSA) is performed by the FAA, to determine whether that introduction of new capability will enhance or detract from the safety of the NAS. As these UAS represent a wholly new operational system, traditional approaches cannot suffice. Research is needed to identify and develop new safety analysis approaches, as well as prognostic indicators and potential new safety metrics.